Preliminary Manual for Model FM-01 Prescaler Module

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Instrumentation

Preliminary Manual
for Model FM-01

Model 8220 Prescaler Module

FAIRCHILD
INSTRUMENTATION

LIST OF EFFECTIVE PAGES

Model FM-01
Prescaler Module

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EQUIPMENT WARRANTY

1. Seller warrants equipment of its manufacture against defective materials or workmanship for a period of one year from date of shipment.

2. The liability of Seller under this warranty is limited, at Seller's option, solely to repair, replacement with equivalent Fairchild equipment, at an appropriate credit adjustment not to exceed the original equipment sales price, of equipment returned to the Seller provided that (a) Seller is promptly notified in writing by Buyer upon discovery of defects, (b) upon receipt of written authorization from Seller the defective equipment is returned to Seller, transportation charges prepaid by Buyer, and, (c) Seller's examination of such equipment discloses to its satisfaction that defects were not caused by negligence, misuse, improper installation, accident, or unauthorized repair or alteration by the Buyer.

3. This warranty does not include mechanical parts failing from normal usage nor does it cover limited life electrical components which deteriorate with age such as vacuum tubes, choppers, lamps, etc. In the case of accessories, i.e., card punches, typewriters, etc., not manufactured by Seller, but which are furnished with the Seller's equipment, Seller's liability is limited to whatever warranty is extended by the manufacturers thereof and transferable to the Buyer.

4. **THIS WARRANTY IS EXPRESSED IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, AND OF ALL OTHER OBLIGATIONS OR LIABILITIES ON THE SELLER'S PART, AND IT NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR THE SELLER ANY OTHER LIABILITIES.**

5. The aforementioned provisions do not extend the original warranty period of any article which has been either repaired or replaced by Seller.

Section I
General Information

1-1. INTRODUCTION

1-2. This manual provides information for installation, operation and maintenance of the Model FM-01 plug-in Prescaler module designed for use with the Model 8220 Digital Frequency Meter. Section I includes a general description of the plug-in toegether with a table of specifications. Section II includes installation instructions. Section III describes operating procedures. Section IV includes theory of operation. Section V provides information for checking performance and making adjustments. Section VI lists replacement parts.

1-3. GENERAL DESCRIPTION

1-4. The FM-01 is a prescaler that extends the direct counting frequency range of the Model 8220 Digital Frequency Meter from 50 MHz to 500 MHz. Prescaling is accomplished by solid-state dividers that operate over the frequency range of 50 MHz to 500 MHz. The unit scales (divides down) the input frequency by a factor of 10 and automatically changes the frequency meter time base to maintain a direct frequency readout. Power for the plug-in is supplied by the Model 8220.

1-5. All components are located on a printed circuit board mounted on the frame of the plug-in assembly. The circuit consists basically of a tunnel diode binary followed by a transistorized quinary giving an overall frequency division of 10.

1-6. SPECIFICATIONS

1-7. Table 1-1 contains specifications for the Model FM-01.

1-8. DIMENSIONS

1-9. Figure 1-1 is an outline drawing of the Model FM-01 showing principal dimensions in inches and centimeters.

Table 1-1. FM-01 Electrical Specifications

FREQUENCY	
Range:	25 MHz to 500 MHz
Accuracy:	Same as Model 8220 Digital Frequency Meter
INPUT	
Connector:	Front panel BNC type
Sensitivity:	100 mV rms
Conditions:	AC coupled Maximum operating level 1 V rms; no damage to FM-01 will occur with up to 5 V rms applied. Impedance 50 Ω approximately.
OUTPUT	
Scaled Output:	AC coupled 0.4 V approximately into 100 Ω load
GENERAL	
Operating Temperature Range:	0° to 50°C
Power Requirements:	150 mA + 12 V DC ±1% 150 mA - 12 V DC ±1% (supplied by Model 8220)
Power and Output Connector:	Circuit board mates with 12-pin double row (24-pin) printed circuit edge connector.

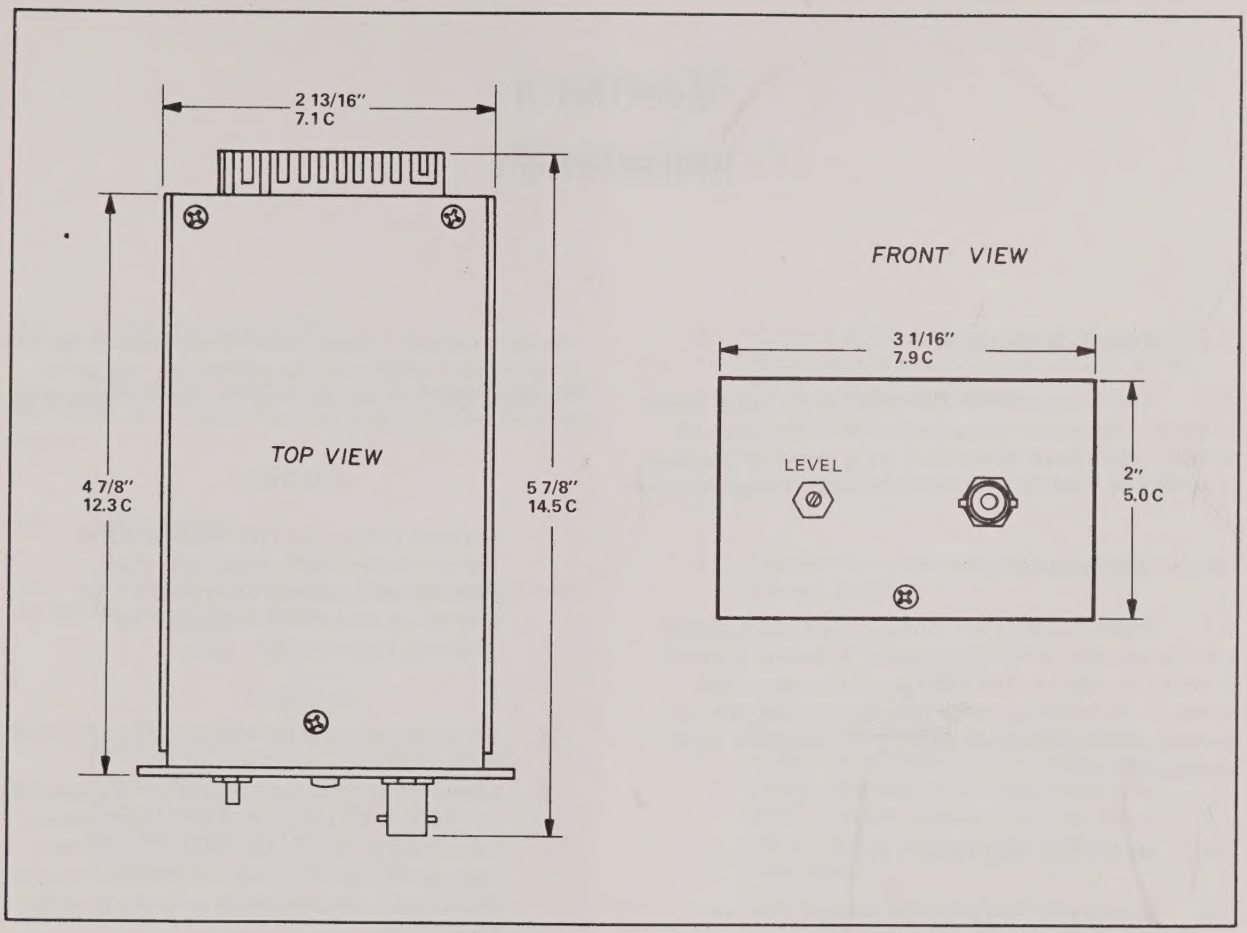


Figure 1-1. Outline Drawing, Model FM-01

Section II
Installation

2-1. SCOPE OF SECTION

2-2. This section contains instructions for initial installation and inspection of the Model FM-01 Prescaler. In addition reshipment instructions are provided in the event that the unit must be returned to Fairchild Instrumentation.

2-3. UNPACKING

2-4. Before releasing the carrier, inspect the packaged unit for any sign of external damage. If damage is noted, it should be called to the attention of the carrier and noted on the receiving receipt. Do not proceed with unpacking until instructed to do so by the authority of its insuring agency.

2-5. MECHANICAL INSPECTION

2-6. Inspect the front panel for damage. Note any scratches or dents. Examine the unit for damage to components, wiring, etc.

2-7. POWER REQUIREMENTS

2-8. The Model FM-01 is designed to operate in conjunction with the Model 8220, and receives its power from that unit.

2-9. PERFORMANCE CHECK

2-10. The Model FM-01 is completely aligned, calibrated, and checked before shipment and is ready for use upon receipt. A quick check to determine if the unit is operating correctly and has suffered no damage in shipment may be made carrying out the following steps:

CAUTION

DO NOT OPERATE THE MODEL 8220/ FM-01 ABOVE 50°C AMBIENT. TEMPERATURES ABOVE THIS LIMIT CAN CAUSE PERMANENT DAMAGE TO TUNNEL DIODES CR5–CR8.

a. Set mode switch of the Model 8220 to PLUG-IN.

b. Connect test cable from coaxial input connector on FM-01 front panel to 50 MHz signal source. Check that readout is 050000.0 kHz ±1 count. Increase frequency in steps to 500 MHz and check that readout remains within accuracy given for Model 8220.

2-11. A detailed alignment and checkout procedure is contained in Section V of this manual.

2-12. RESHIPMENT

2-13. When an instrument is damaged in shipment, the insurance investigator can order it returned. The responsibility for repacking and reshipment is the insurance company's. Neither the customer or Fairchild Instrumentation are required to assume such responsibility without specific understanding with the insurance company through proper representatives.

Section III
Operation

3-1. SCOPE OF SECTION

3-2. This section contains operating instructions when the FM-01 is used with the Model 8220 Digital Frequency Meter.

3-3. OPERATION

3-4. To operate the Model 8220 in conjunction with the FM-01; proceed as follows:

CAUTION

DO NOT OPERATE THE MODEL 8220/ FM-01 ABOVE 50°C AMBIENT. TEMPERATURES ABOVE THIS LIMIT CAN CAUSE PERMANENT DAMAGE TO TUNNEL DIODES CR5–CR8.

a. Connect signal cable to coaxial connector on front panel of FM-01. Refer to table 3-1 for FM-01 input characteristics.

b. Set Model 8220 mode switch to PLUG-IN.

c. Connect test cable to signal source and observe readout in kHz.

NOTE

The LEVEL control on the front panel of the FM-01 should be used only when a noisy sine wave or low amplitude pulse train is being measured. For these inputs, adjust LEVEL control for maximum stable readout.

Table 3-1. FM-01 Input Characteristics

Range:	25 MHz to 500 MHz
Sensitivity:	100 mV rms
Impedance:	Approximately 50 Ω
Standing Wave Ratio:	1: 1.35
Coupling:	AC coupled
Maximum Input:	Operating level 1 V rms; up to 5 V rms without damage.
Input Connector:	BNC type

Section IV
Theory of Operation

4-1. SCOPE OF SECTION

4-2. This section contains a description of the theory of operation of the Model FM-01 Prescaler. The theory consists of a general description of operating principles followed by a discussion of circuit operation. Reference should be made to figure 5-3 for a detailed schematic of the unit.

4-3. GENERAL DESCRIPTION

4-4. The FM-01 Prescaler is a solid-state frequency divider that operates over the frequency range of 50 to 500 MHz and scales the input frequency by a factor of 10. Referring to figure 4-1, the input signal is fed to an amplifier and shaper that drives a tunnel diode binary counter. This circuit divides the events at the input by 2 and its output drives a quinary stage that divides the binary output by 5. This gives a total division by 10. The output of the quinary drives a Schmitt trigger whose output is coupled via the "PLUG-IN" position on the Model 8220 Function switch to the input of the meter. Other sections of the Function switch select the .1 sec gate interval and place the decimal point to the appropriate position in the digital readout.

4-5. CIRCUIT DESCRIPTION

4-6. The input signal is applied to the prescaler through diode bridge CR1—CR4, limiting the input to 600 mV. From the bridge the signal is applied to broadband amplifier Q3/Q4 which has a gain of approximately 3 and an input impedance of 50 Ω. Transistor Q3 is connected in a common emitter configuration with R2 in parallel with R21 establishing the input impedance. Transistor Q4 is a common base amplifier that turns Schmitt trigger tunnel diode CR5 on and off. CR5 is used to sharpen the leading edge of the signal for good triggering action. The signal across CR5 is differentiated by R27 and L2 and fires tunnel diode single-shot CR6. The output of CR6 is connected to a level shifter (CR18 and C15) whose output is applied to binary stage CR7/CR8.

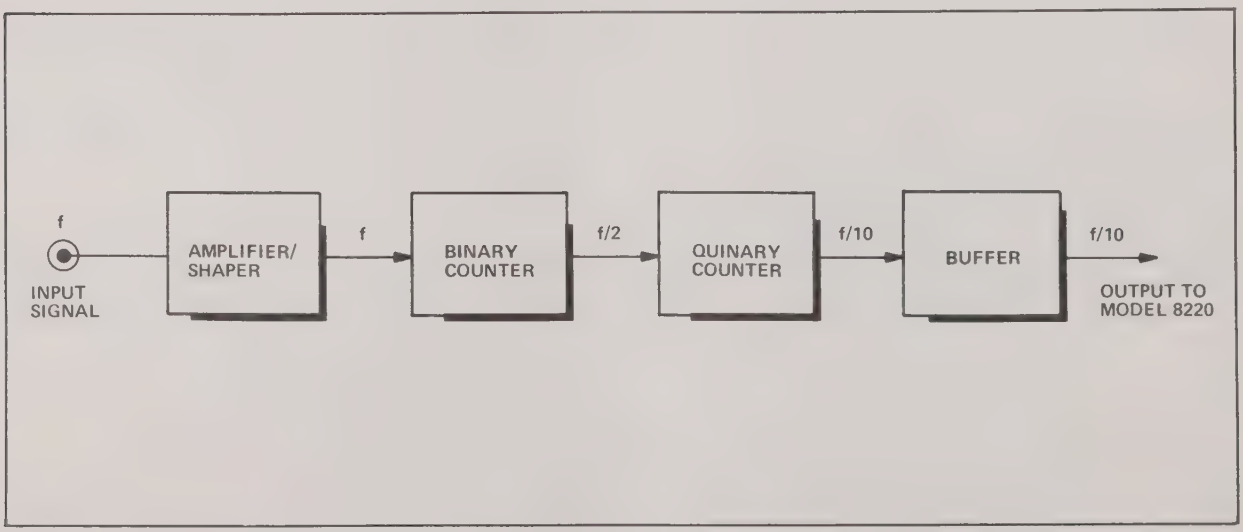


Figure 4-1. Model FM-01 Block Diagram

4-7. The binary stage includes tunnel diodes CR7 and CR8, inductor L4 and resistors R31 and R32. When stabilized, bias causes one tunnel diode to be in the high voltage state and the other in the low voltage state with the current from L4 flowing through the diode in the low voltage state. A pulse across CR7 switches the diode in the high voltage state so that both diodes change to the low voltage state. When the pulse decays, the current flowing in L4 causes a larger current to flow through the original low voltage diode, switching it to the high voltage state. Two input pulses change the output state; thus circuit acts as a binary divider.

4-8. The output of the binary stage is applied to current mode switch Q5/Q6 which converts the signal to a constant voltage of 0.5 V. From the switch, the signal is fed to the quinary ring counter via emitter follower driver stage Q7.

4-9. The quinary ring counter consists of five current mode switches consisting of transistors Q10 through Q19, zener diodes CR12 through CR16, and resistors R37 through R51. The trigger input from Q7 is common to the bases of input transistors Q10 through Q14. Emitter current from the -12 V supply is applied to the input transistors across resistors R37 through R41. The collector supply is provided by the +12 V supply across resistors R47 through R51. The second stages are transistors Q15 through Q19 with the collector of the first stage connected to the base of the second stage across a zener diode (CR12 through CR16). R42 through R46 are load resistors to ground.

4-10. Circuit operation is as follows: As an example, current passing through R47 has a choise of 3 return paths: the collector of Q19, the collector of Q10 and zener diode CR12. If 15 mA flows through R47 at all times, and both Q19 and Q10 are off, the entire 15 mA flows through CR12 and load resistor R42. The voltage across R42 is +1.5 V, which the base of Q15 sees as a bias. Since Q10 is turned off, Q15 must be on and for this to be true, the voltage on the base of Q10 must be less than +1.5 V. Since the base of Q10 is common to the bases of Q11, Q12, Q13 and Q14, the bases of these transistors are biased at some value less than +1.5 V. Collector resistor R48 supplies Q15 and Q11. At this point Q11 is turned on. Since the value of the emitter supply resistors provide a current of 6.7 mA to their respective stages, Q15 will draw 6.7 mA from R48, as will Q11. Only 1.6 mA is left to flow through CR13 and R43. The voltage across R43 is therefore +.2 V, the bias on the base of Q16 which is turned off. (Q11 is on.) Therefore, the voltage on the base of Q11 and the other four transistors must be greater than +.2 V. It is established that the bias on the bases of the input transistors is greater than +.2 V and less than +1.5 V. the order of transistors turned on and off is shown below:

Q10	ON	Q15	OFF
Q11	OFF	Q16	ON
Q12	ON	Q17	OFF
Q13	OFF	Q18	ON
Q14	ON	Q19	OFF

With Q19 off and Q10 on, a total of 8.3 mA flows through zener CR12 and load resistor R42. The bias on the base of Q15 is 0.85 V. For Q15 to be turned off, the base of Q10 must be greater than 0.85 V. It is now established that the bias on the bases of the input transistors is greater than 0.85 V and less than 1.5 V.

4-11. From this point a counting sequence can be established. If the input bias moves to a value of less than 0.85 V, Q10 will be turned off and Q15 on. With Q10 off, a total of 15 mA flows through CR12 and and R42. The base of Q15 is now biased to 1.5 V. With Q15 turned on, only 8.3 mA flows through CR13 and and R43. The bias on the base of Q16 is 0.85 V. This condition remains until the input bias rises to a value greater than 0.85 V at which time Q11 will turn on and Q16 off as its base drops to 0.2 V. This new order of on and off transistors, listed below, is the condition of the circuit after one complete negative going pulse has been applied to the input.

Q10	OFF	Q15	ON
Q11	ON	Q16	OFF
Q12	ON	Q17	OFF
Q13	OFF	Q18	ON
Q14	ON	Q19	OFF

4-12. Figure 4-2 shows the bias relationships between the load resistors of each stage during a complete scaler cycle of five counts from the tunnel diode binary stage. The output is taken from R46 and drives Q8 and Q9, a current mode Schmitt trigger that supplies output pulses to the Model 8220 input circuit.

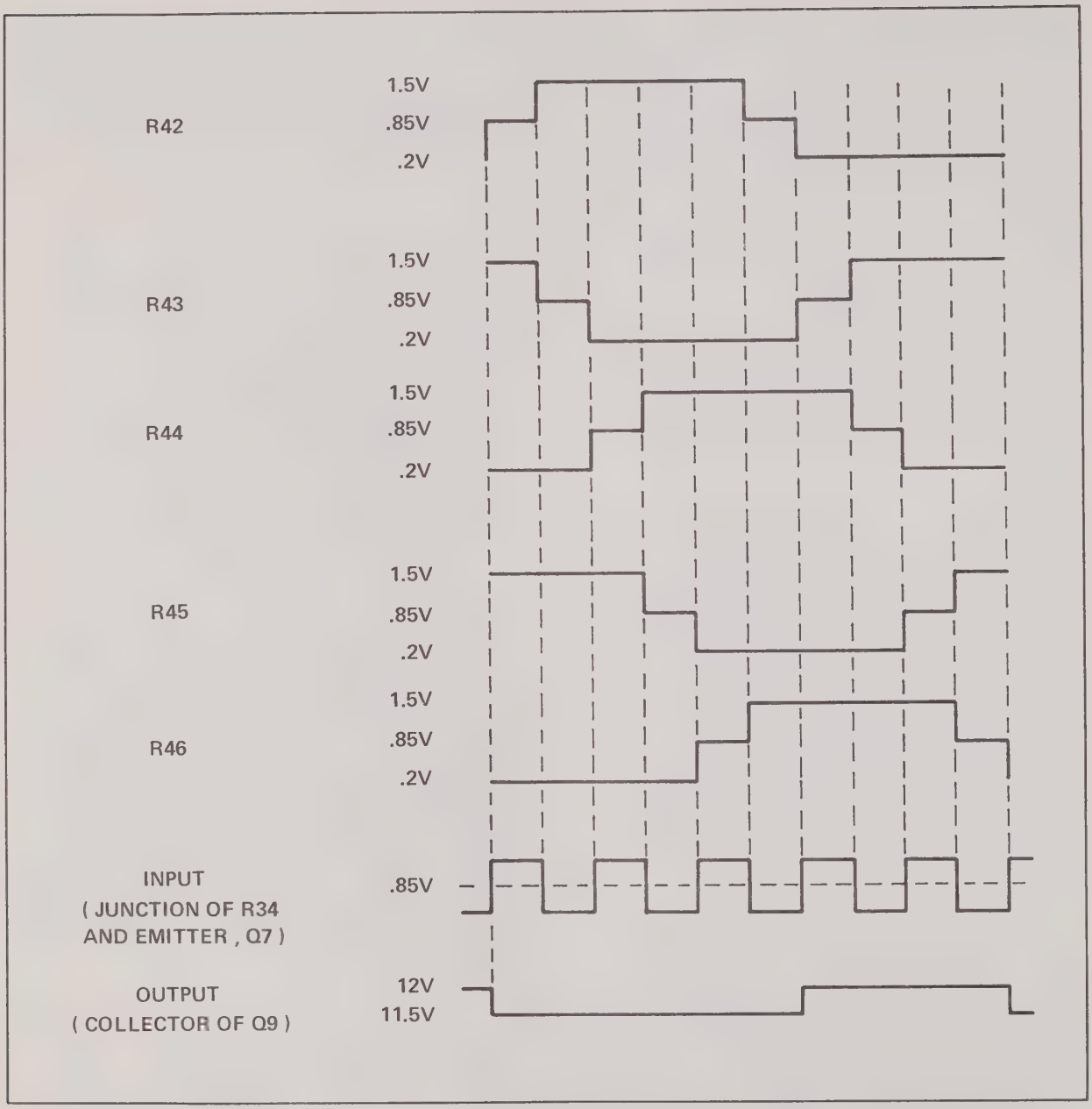


Figure 4-2. Quinary Waveforms

Section V
Maintenance

5-1. SCOPE OF SECTION

5-2. This section contains instructions for calibration and maintenance of the Model FM-01 including a list of test equipment used.

5-3. TEST EQUIPMENT REQUIRED

5-4. Table 5-1 lists test equipment required to check the alignment of the FM-01. If the listed equipment is not available, instruments with equivalent specifications may be substituted.

Table 5-1. Test Equipment Required

Equipment Type	Specifications		Recommended Instrument
Ultra High Frequency Signal Generator	Frequency range: Output level:	10 to 480 MHz 0.1 μV to 1 V into 50 Ω	Hewlett-Packard Model 608C
Ultra High Frequency Signal Generator	Frequency range: Output level:	450 to 1230 MHz 0.1 μV to 0.5 V into 50 Ω	Hewlett-Packard Model 612A
Power Meter	Power range: Accuracy:	10 μW to 10 mW 0 to 55°C ±3% of full scale on all ranges.	Hewlett-Packard Model 431C
General Purpose Oscilloscope			Tektronix Type 561A
Dual Trace Sampling Plug-In			Tektronix Type 3S76
Sampling Probe	X10, passive, 500 Ω impedance		Tektronix Type P6034
Integrating Digital Multimeter	Readout range: Resolution:	0-15 V min. 1 mV	Fairchild Model 7050

5-5. PERFORMANCE CHECK

5-6. The following procedure may be used as a part of periodic maintenance on a regular basis.

CAUTION

DO NOT OPERATE THE MODEL 8220/ FM-01 ABOVE 50°C AMBIENT. TEMPERATURES ABOVE THIS LIMIT CAN CAUSE PERMANENT DAMAGE TO TUNNEL DIODES CR5–CR8.

a. Insert FM-01 in a serviceable Model 8220. Set mode switch to PLUG-IN.

b. Fit test cable to input coaxial connector on front panel of FM-01. Connect cable to 50 MHz, 100 mV rms signal source. Check that readout is 050000.0 kHz ±1 count.

c. Change input signal to 500 MHz, 100 mV rms. Check that readout is 500000.0 kHz ±1 count.

5-7. CALIBRATION PROCEDURE

5-8. The following procedure should be used only if components are replaced or if tests show that adjustment is required. Figure 5-4 shows the location of adjustments called out in the text, figure 5-5 shows test points, and figure 5-1 shows typical operating waveforms.

5-9. **Preliminary Adjustments**

a. Withdraw FM-01 from front panel of Model 8220. Remove top shield from FM-01.

b. Insert extender board No. 813459 in place of FM-01. Plug FM-01 into connector on extender board.

5-10. **Input Voltage**

a. Set Model 8220 POWER switch to ON and Function control to PLUG-IN.

b. Measure DC voltage at pin A of extender board, use pin 12 for GND. Voltage should be -12 V ±0.1%.

c. Check voltage at pin B. Reading should be +12 V ±1%.

5-11. **Basic Alignment**–(If unit is operating proceed to the final alignment section of this procedure.)

a. Connect DVM to TP3. Adjust R54 for reading of +8.50 V.

b. Connect HP Model 608C or equivalent signal generator to FM-01. Input connector. Adjust generator for a 50 MHz, 200 μW (280 mV p-p) output.

c. Using 500 Ω (or greater) probe, connect oscilloscope with dual trace sampling plug-in to TP6. Adjust R52 (FM-01 LEVEL control) for a 500 mV p-p square wave with a 20 nsec period. See figure 5-1 (a).

d. Connect probe to TP8. Adjust R53 for a negative going pulse with an amplitude of 250 mV or more and a width of less than 1 nsec. See figure 5-1 (b). Set R53 to center of its operating range.

e. Connect probe to TP9. Use DC coupling. Adjust R54 for a 400 mV p-p square wave with a period of 40 nsec. See figure 5-1 (c). Measure and note DC level of waveform. Set R54 to center of the operating range.

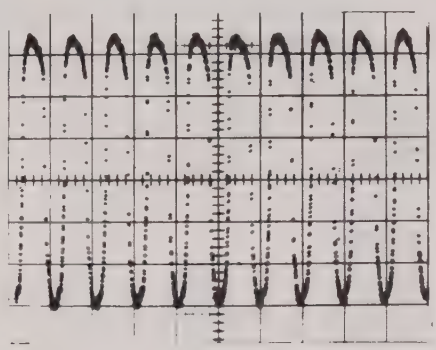
f. Connect probe to TP10. Use DC coupling. Adjust R55 until DC level of signal observed is 50 mV less than DC level noted in step e.

g. Adjust R56 for readout of 50 MHz on Model 8220. Set R56 to center of its operating range.

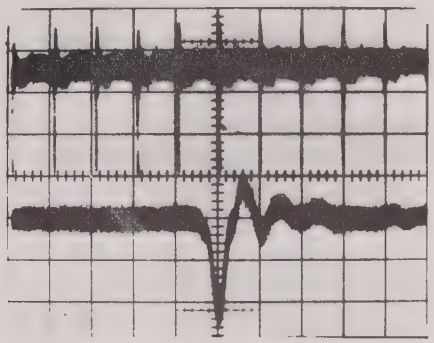
h. Remove Model 608C generator and connect HP Model 612A generator or equivalent. Adjust for a 500 MHz, 200 μW (280 mV p-p) output.

i. Check that Model 8220 readout indicates 500 MHz. If this is not the case, make small adjustments of R54, R56, R55, R52 and R53 in the order given. If rotation of a control has no effect on the readout, return it to the original setting before proceding to adjustment of the next control.

j. Recheck that readout with 50 MHz, 200 μW input is 50 MHz. Repeat adjustments described in step i until readout is correct for 50 MHz and 500 MHz inputs.

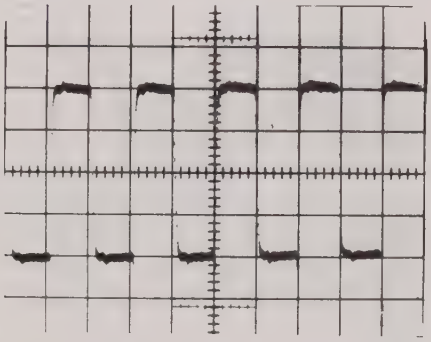


(a) TP6 *Vert: 100 mV/div*
Horiz: 20 nsec/div
Freq: 50 MHz

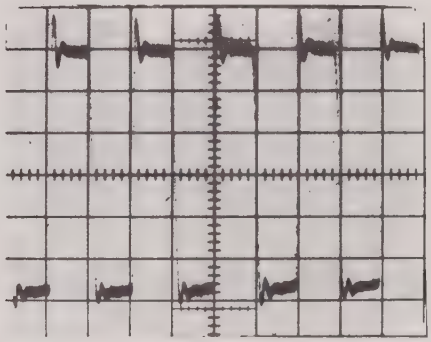


(b) TP8

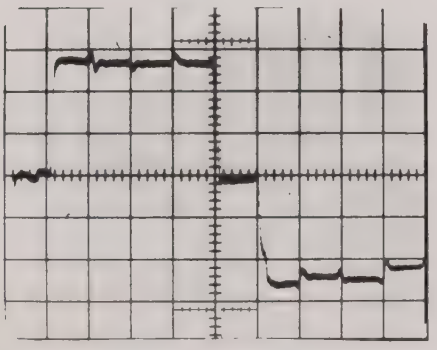
	Upper	Lower
Vert:	100 mV/div	100 mV/div
Horiz:	20 nsec/div	1 nsec/div
Freq:	50 MHz	50 MHz



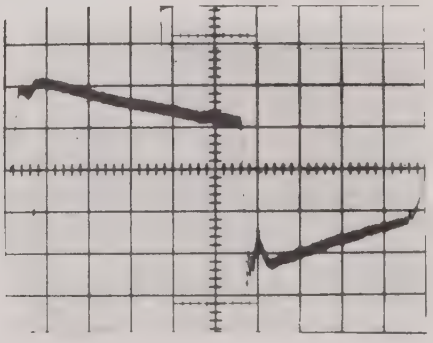
(c) TP9 *Vert: 100 mV/div*
Horiz: 20 nsec/div
Freq: 25 MHz



(d) TP12 *Vert: 100 mV/div*
Horiz: 20 nsec/div
Freq: 25 MHz



(e) TP11 *Vert: 200 mV/div*
Horiz: 20 nsec/div
Freq: 5 MHz



(f) Pin M *Vert: 100 mV/div*
Horiz: 20 nsec/div
Freq: 5 MHz

Figure 5-1. Test Waveforms

5-12. **Final Alignment**

a. Apply a 50 MHz, 200 μW signal to input. Connect DVM to TP9. Use DVM input circuit shown in figure 5-2 for this, and all other DC signal level measurements called for in the remainder of this procedure. Measure and record voltage at TP9.

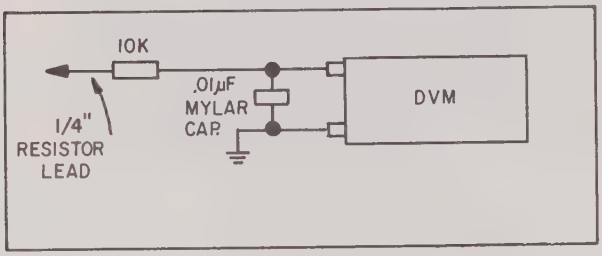


Figure 5-2. DVM Input Circuit

b. Connect DVM to TP10. Adjust R55 until TP10 voltage equals TP9 voltage minus 50 mV.

c. Recheck voltage at TP9 and TP10. If necessary readjust R55 until desired 50 mV differential is obtained. Check that Model 8220 still reads 500 MHz.

d. Connect DVM to TP11. Measure and record voltage.

e. Connect DVM to TP12 (center of quinary). Adjust R56 until voltage equals voltage noted at TP11.

f. Recheck voltage at TP11 and TP12. If necessary readjust R56 until both readings are equal.

g. Apply a 50 MHz, 100 μW signal to input.

h. Connect probe to TP7. Adjust R52 until a symmetrical waveform is observed on oscilloscope. Decrease amplitude of input signal in small increments and adjust R52 for symmetry with each change. Continue until waveform ceases to be well defined and readout indicates mis-dividing.

i. Connect DVM to TP3. Adjust R54 for a reading of 8.50 V.

j. Connect probe to TP12 and DVM to TP2. Set signal generator for a 50 MHz, 400 μW input.

k. Adjust R53 to determine upper and lower voltage (TP2) at which waveform (TP12) distorts or disappears. Note and record results. Repeat for 400 μW, 250 MHz and 500 MHz inputs.

l. Increase input signal level to 20 mW and repeat R53 adjustments at 500 MHz, 250 MHz and 50 MHz. Note results. Typical readings for steps k and l are given below. Calculate Δ, Δ/2, and center setting of R53 as shown in figure 5-3.

Step 1 R54 = 8.50 V

INPUT SIGNAL		V at TP2	
FREQ.	Amp.	MIN.	MAX.
500	400 μW	9.05	8.65
250	400 μW	9.00	8.65
50	400 μW	9.05	8.75
500	20 mW	8.65	10.35
250	20 mW	8.65	10.75
50	20 mW	8.75	10.00

Low Maximum	=	10.00 V
High Minimum	=	9.05 V
Δ = Low Max.—High Min.	=	.95 V
Δ/2	=	.48 V
Center = Δ/2 + High Min.	=	9.53 V

m. Connect DVM to TP3. Adjust R54 for reading of 8.25 V. Return DVM to TP2 and repeat steps k and l. Continue to decrease R54 voltage in .25 V increments until a Δ value is calculated that is at least 50% less than the largest Δ recorded.

n. Connect DVM to TP3. Adjust R54 reading of 8.75 V. Return DVM to TP2 and repeat steps k and l. Continue to increase R54 voltage in .25 V increments until a Δ value is calculated that is at least 50% less than the greatest Δ recorded.

o. Connect DVM to TP3 and set R54 to optimum setting. This may be determined by plotting R54 voltage vs. Δ readings obtained in steps k through n. Figure 5-3 shows a typical curve. The optimum point is 8.15 V. R53 is then set to obtain the calculated center voltage of 9.45 V.

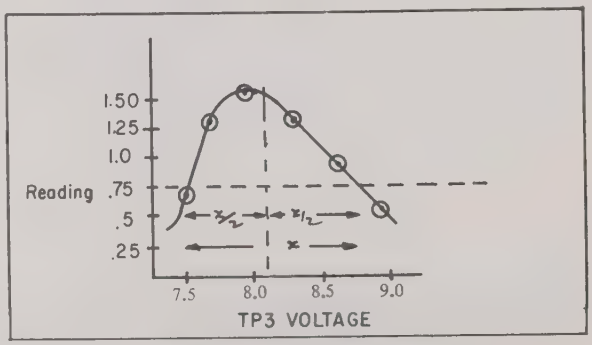


Figure 5-3. Test Curve

5-13. PARTS LOCATION AND SCHEMATIC

5-14. Figure 5-4 shows the location of all electronic components contained in the FM-01 and figure 5-5 is a detailed schematic of the unit.

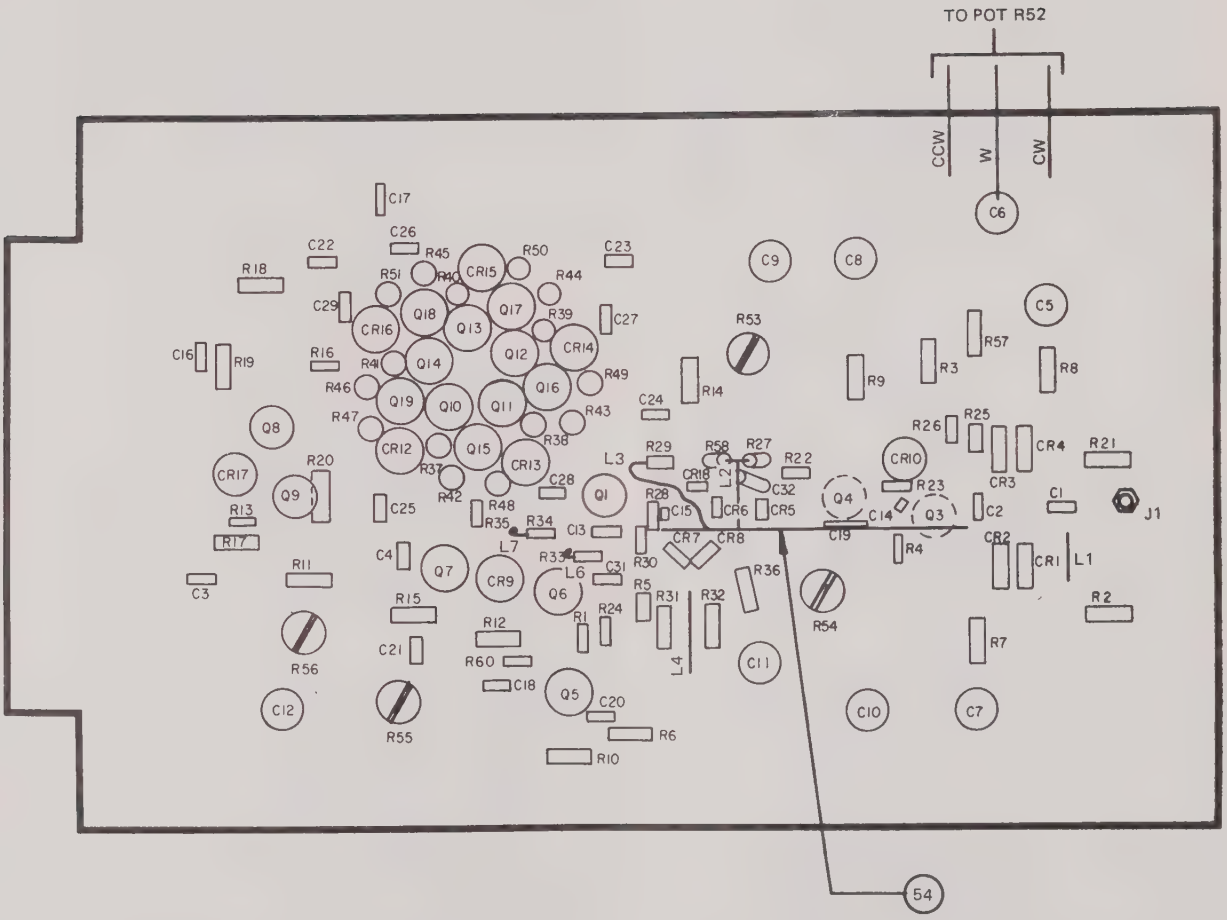


Figure 5-4. Component Location, FM-01

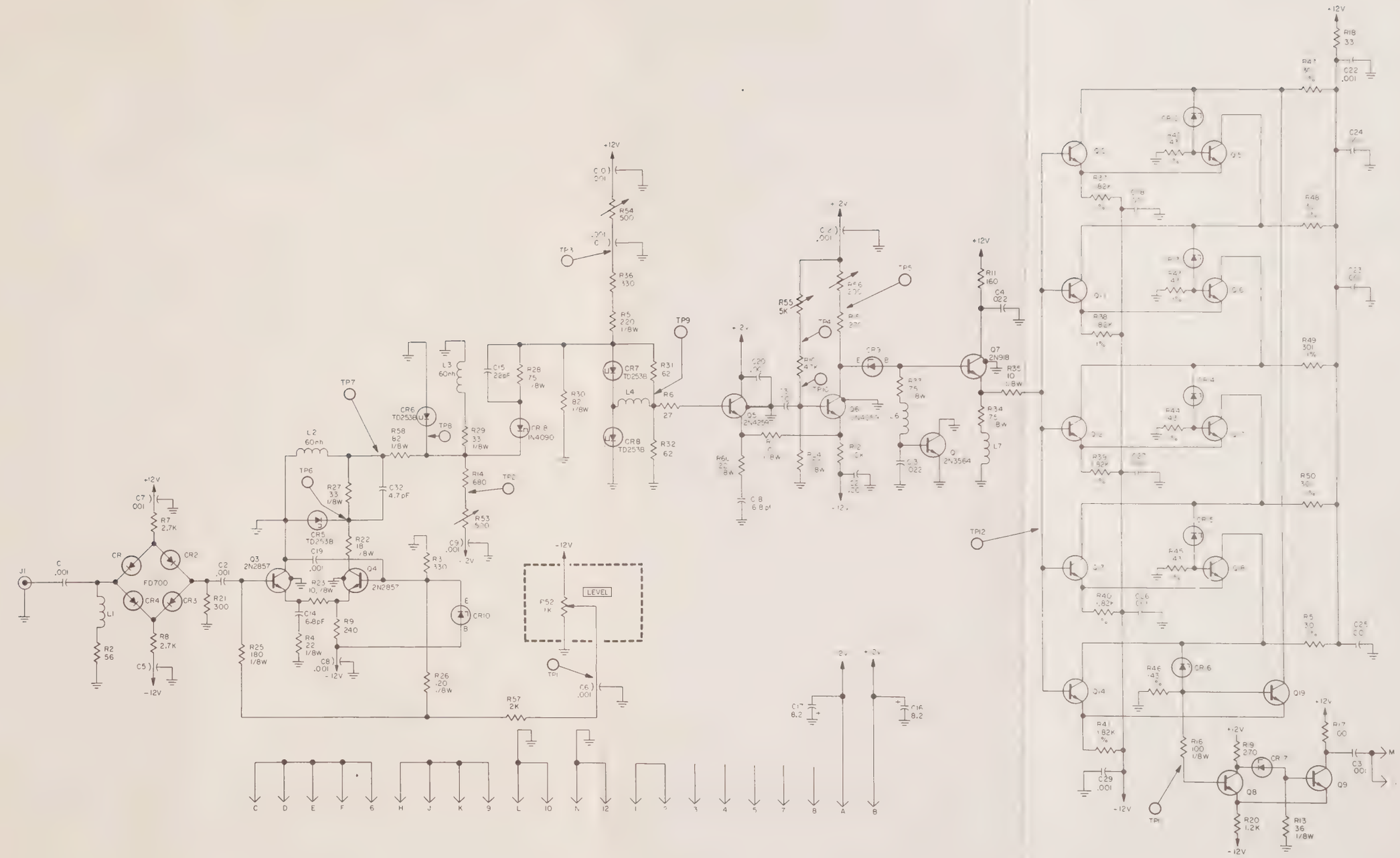


Figure 5-5. Schematic, FM-01

Section VI
Replacement Parts

6-1. GENERAL

6-2. Table 6-1 contains information for ordering replacement parts and lists: circuit reference, description, manufacturer, and Fairchild Instrumentation part number.

6-3. ORDERING INFORMATION

6-4. To order a replacement part, address order to an authorized Fairchild Instrumentation sales representative or to: 974 East Arques Avenue, Sunnyvale, California 94086.

6-5. Specify the following for each part:

a. Model and serial number of instrument.

b. Fairchild Instrumentation part number.

c. Circuit reference designation, assembly number, or complete description.

6-6. To order a part not listed in table 6-1, provide a complete description of the part, including function and location.

ABBREVIATIONS

AB	Allen-Bradley Company
Aerovox	Aerovox Corporation
Amphenol . . .	Amphenol Corporation
FI.	Fairchild Instrumentation
FS	Fairchild Semiconductor

Table 6-1. Model FM-01 Parts List

Circuit Ref.	Description	Manufacturer	Number
C1	Capacitor, fixed, 1000 pF	Aerovox	03290560
C2	Same as C1		
C3	Same as C1		
C4	Capacitor, fixed, .022 μF		03290520
C5	Capacitor, fixed, 1000 pF		03290510
C6 through C12	Same as C5		
C13	Same as C4		
C14	Capacitor, fixed, 6.8 pF		03290530
C15	Capacitor, fixed, 22 pF		03290540
C16	Capacitor, fixed, 8.2 μF, 15 V		03287360
C17	Same as C16		
C18	Same as C14		
C19	Capacitor, fixed, 1000 pF	Sprague	03287080
C20 through C29	Same as C1		
C30	Not assigned		
C31	Same as C1		
C32	Capacitor, fixed, 4.7 pF		03290730
CR1 through CR4	Diode, FD700	FS	26011740
CR5	Diode, TD253B	FS	26013820
CR6	Same as CR5		
CR7	Diode, TD253B, Matched pair	FS	26003451
CR8	Matched with CR7		
CR9	Transistor, S18619	FS	26003611
CR10	Same as CR9		
CR11	Not assigned		
CR12 through CR17	Same as CR9		
CR18	Diode, 1N4090		26015980
J1	Coaxial Connector	Amphenol	09068100
Q1	Transistor, 2N3564	FS	26012620
Q2	Not assigned		
Q3	Transistor, 2N2857	FS	26015990
Q4	Same as Q3		
Q5	Transistor, 2N4259	FS	26016210

Table 6-1. Model FM-01 Parts List (Continued)

Circuit Ref.	Description	Manufacturer	Number
Q6	Same as Q5		
Q7	Transistor, 2N918 Selected	FI	26005081
Q8 through Q19	Transistor, S18620	FS	26003581
R1	Resistor, fixed, 10 Ω ±5%, 1/8 W	AB	02395200
R2	Resistor, fixed, 56 Ω ±5%, ¼ W	AB	02354320
R3	Resistor, fixed, 330 Ω ±5%, ¼ W	AB	02354500
R4	Resistor, fixed, 22 Ω ±5%, 1/8 W	AB	02395280
R5	Resistor, fixed, 220 Ω ±5%, 1/8 W	AB	02395520
R6	Resistor, fixed, 27 Ω ±5%, ¼ W	AB	02354240
R7	Resistor, fixed, 2.7 kΩ ±5%, ¼ W	AB	02354710
R8	Same as R7		
R9	Resistor, fixed, 240 Ω ±5%, ¼ W	AB	02354470
R10	Resistor, fixed, 4.7 kΩ ±5%, ¼ W	AB	02354770
R11	Resistor, fixed, 160 Ω ±5%, ¼ W	AB	02354430
R12	Resistor, fixed, 1.2 kΩ ±5%, ¼ W	AB	02354640
R13	Resistor, fixed, 36 Ω ±5%, 1/8 W	AB	02395330
R14	Resistor, fixed, 680 Ω ±5%, ¼ W	AB	02354580
R15	Resistor, fixed, 270 Ω ±5%, ¼ W	AB	02354480
R16	Resistor, fixed, 100 Ω ±5%, 1/8 W	AB	02395440
R17	Resistor, fixed, 100 Ω ±5%, ¼ W	AB	02354380
R18	Resistor, fixed, 33 Ω ±5%, ¼ W	AB	02354260
R19	Same as R15		
R20	Same as R12		
R21	Resistor, fixed, 300 Ω ±5%, ¼ W	AB	02354490
R22	Resistor, fixed, 18 Ω ±5%, 1/8 W	AB	02395260
R23	Same as R1		
R24	Same as R16		
R25	Resistor, fixed, 180 Ω ±5%, 1/8 W	AB	02395500
R26	Resistor, fixed, 120 Ω ±5%, 1/8 W	AB	02395460
R27	Resistor, fixed, 33 Ω ±5%, 1/8 W	AB	02395320
R28	Resistor, fixed, 75 Ω ±5%, 1/8 W	AB	02395410
R29	Same as R27		
R30	Resistor, fixed, 82 Ω ±5%, 1/8 W	AB	02395420
R31	Resistor, fixed, 62 Ω ±5%, ¼ W Matched pair	AB	02392401
R32	Matched with R31		
R33	Same as R28		
R34	Same as R28		
R35	Same as R1		
R36	Same as R3		
R37	Resistor, fixed, 1.82 kΩ ±1%, ¼ W	AB	02365930

Table 6-1. Model FM-01 Parts List (Continued)

Circuit Ref.	Description	Manufacturer	Number
R38 through R41	Same as R37		
R42	Resistor, fixed, 143 Ω ±1%, ¼ W	AB	02364870
R43	Same as R42		
R44	Same as R42		
R45	Same as R42		
R46	Same as R42		
R47	Resistor, fixed, 301 Ω ±1%, ¼ W	AB	02365180
R48	Same as R47		
R49	Same as R47		
R50	Same as R47		
R51	Same as R47		
R52	Resistor, variable, 1 kΩ		01110080
R53	Resistor, variable, 500 Ω		01110050
R54	Same as R53		
R55	Resistor, variable, 5 kΩ		01110060
R56	Resistor, variable, 200 Ω	Amphenol	01111720
R57	Resistor, fixed, 2 kΩ ±5%, ¼ W	AB	02354680
R58	Same as R30		
	Miscellaneous		
	Connector, RF Subminiature		09067840
	Cover, top		33041521
	Shield		42026301
	Socket, Component Lead		09067370
	PC Board		40034971
	Front Panel		32015541

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